N.A.C.A. BULLETIN

In Two Sections

Section One

LABOR COST DETERMINATION AND CONTROL IN A COTTON TEXTILE MILL
by J. D. DUSKIN 131

COST PROBLEMS FOR WEST COAST ALUMINUM
by LEONARD A. DOYLE 145

A SIMPLIFIED INVENTORY PROCEDURE
by RICHARD C. FOX 164

VOL. XXIX, NO. 3 OCTOBER 1, 1947

EDITORIAL DEPARTMENT NOTE

The manufacture of cotton textiles is a highly technical as well as competitive undertaking. The competition is keen, not only within the industry, but companies must compete with those producing synthetic and other textiles. The determination and control of costs is therefore important.

J. D. DUSKIN, author of the first article in this issue, worked for several years prior to the war with the Bibb Mfg. Co. in Macon and Columbus, Ga., and with the Riverside and Dan River Cotton Mills, Inc., in Danville, Va., doing time study and cost work. During the war he served for over three years as an AAF administrative officer. Since his return from the service he has been engaged in cost accounting work with the Columbus Mfg. Co., Columbus, Ga., manufacturers of cotton sheetings.

•

Aluminum represents an industry in which competition is rapidly developing. As a result of the war and in contrast to many other metals, aluminum is, as a recent writer stated, in plentiful supply and priced substantially below prewar levels. As a substitute for steel, however, it operates in a buyers' market. Hence, control over its production costs may well determine the degree of success in competing with ferrous metals.

LEONARD A. DOYLE, author of the second article, is Assistant Professor of Accounting at the University of California. At the present time he is on leave of absence from the university, acting as Director of Economic Research for the Permanente Metals Corp. He is a graduate of Antioch College in Yellow Springs, Ohio, received his Ph.D. degree in economics from Ohio State University, and holds C.P.A. certificates in New York and California. He is largely responsible for the cost accounting system for aluminum production which he describes in his paper.

•

The last article in the current issue deals with a simplified inventory procedure. The reader must bear in mind that it is a case study and that its applicability to other plants depends on local conditions and the possibility of modifying the system to meet such conditions.

RICHARD C. FOX, the author, was born at Lock Haven, Pa., and received his education in the public schools of that city. Upon completion of high school, he studied Alexander Hamilton courses in general and cost accounting. He has been with General Armature & Mfg. Co. since 1935 and is at present Chief Cost Accountant.

This *Bulletin* is published semimonthly by the National Association of Cost Accountants, 385 Madison Ave., New York 17, N. Y. Subscription price, $10.00 per year. Entered at the Post Office, New York, N. Y., as second-class matter August 28, 1925, under the Act of March 3, 1879.

COPYRIGHTED BY THE
NATIONAL ASSOCIATION OF
COST ACCONTANTS
OCTOBER 1, 1947

LABOR COST DETERMINATION AND CONTROL IN A COTTON TEXTILE MILL

by J. D. DUSKIN,
Columbus Manufacturing Co.,
Columbus, Ga.

IN A manufacturing business, any ordinary segregation, together with proper closing adjustments, of the various expense items incident to the manufacturing process serves to reveal the total cost of manufacturing for the accounting period. If this total cost is then divided by the total number of units produced during the period, we obtain the average cost per unit. Knowing what each unit costs us to produce, we are in a better position to market our product, for we can tell in advance which sales prices should yield a profit. Also, if we make a simple analysis and comparison of the various expense items of one accounting period with another, it may be that we can point to certain efficiencies or deficiencies in our processes, machinery layouts, or labor utilization which should be encouraged or discouraged by management. This is the simplest form of cost accounting. While general accounting pictures the financial conditions and operations of the business as a whole, cost accounting seeks to find the unit costs; and having found them, to analyze the component parts with a view to controlling and lowering the unit costs.

Unfortunately, only a few manufacturing businesses lend themselves to such a simple application as the one described above. Few, indeed, are the plants which make only one product with absolutely no variations, however small, in styling. More often the same basic product may be made in a variety of styles or patterns. For example, in a cotton textile mill making gray cloth, the different cloth constructions being made are probably numbered in the dozens, whereas a fancy goods mill probably has hundreds of styles and patterns. It may readily be seen that to divide the total cost of manufacturing by the total yards or pounds produced of all styles lumped together would give a meaningless average cost. Certainly, sales prices for the different styles cannot be based on such an average cost. Moreover, comparison of this average unit cost with one similarly arrived at for a previous period would not provide any clue as to the relative manufacturing efficiencies of the two periods, unless exactly the same styles in the same

proportions were run in both periods. The task, then, of determining what proportions of the total cost should properly be borne by the different styles becomes a rather complex one.

Actual vs. Standard Costs

The cost elements may be distributed to the different products or styles on the basis of actual or standard costs. The former is self-evident; the latter are the result of distributions of costs and expense as they are expected to be. For example, an iron foundry making castings to order would probably find a segregation of actual costs by jobs to be the most advantageous. The cotton textile industry, with its standardized processes, almost exclusively finds a form of standard or predetermined costing to be better adapted to its needs. But whether the method of cost finding be by the use of actual or standard costs, it may be said that there is but one correct distribution of costs to the units of production, which will result in the exact cost incurred in producing the unit. However, to achieve this one correct distribution is a practical impossibility, so we must content ourselves with that distribution which it is believed comes closest to perfection without at the same time being so complicated as to make it unwieldly in operation.

Cost Elements

Standard costs are arrived at by distributing the expected costs over the expected conditions of operation, or operating standards. By measuring periodically the degree of adherence to these standards, we are in a position to know to what extent our standard costs must be corrected in order to reflect actual costs of production; and by disclosing the specific factors which have caused us to vary from the performance goals, or standards, we are provided with the information which, if followed by corrective action, will lead to lower unit costs and a resultant increase in the spread between income and outgo on the operating statement.

The various elements of cost are generally grouped into three principal categories of labor, material, and overhead or burden. If we take a yard of finished cloth from the cloth room, the cost of the raw material used in its production can be determined easily by multiplying the weight of the yard of cloth by an appropriate multiplier to allow for waste and size content. When the weight of raw cotton required is thus obtained, it is multiplied by the price per pound of cotton of the grade and staple used. It is not so

easy, however, to arrive at the cost of all of the different types of labor which contributed to the making of the yard of cloth—from the labor of the opening room hand who fed the cotton into the opening machine to the weaver who wove the cloth. In addition, there is the cost of the indirect assistance of such labor as the oiler who lubricated the spinning frames in order that the yarn might be spun, the sweeper who kept the card room floor clean, and the spooler room overseer who supervised the workers engaged in preparing the yarn for weaving. All contributed to the making of that yard of cloth, and if we are to know the cost of the labor which went into the making of it, we must make a complete analysis of all factors which have affected the labor element.

It is not so easy, either, to determine the overhead cost which the yard of cloth must absorb—such items as the depreciation of the plant and its machinery, the cost of insuring the plant against fire loss, and the telephone and telegraph expense of the plan.

Of the three elements of cost, the material element lends itself most easily to cost determination and to cost control. The overhead element is not so easily determined, but is fairly easily controlled, since its major items are relatively large and generally receive close scrutiny from management. However, without minimizing the importance of the determination or control of the material or overhead elements, our purpose here will be to illustrate a method of developing labor cost and to show some of the information concerning efficiency, production reports, and labor utilization to be derived from the use of the cost figures.

Spinning Labor Development

Labor costs are developed by departments or processes. Thus we have a standard cost per pound for opening and picking, another for the carding process, another for the drawing process, and so on. The total cost of manufacturing for a certain size yarn is arrived at by totalling the per pound labor costs for all the processes required in making the particular yarn (with reasonable allowances for waste), an appropriate distribution of the overhead cost for each process, and the material cost.

In the spinning department our goal is to determine the standard labor cost per pound of yarn for each of the different yarn sizes being run. By standard labor cost we mean the labor cost we should have if all operating conditions are exactly as called for by the standards. That is, (1) the department has the exact comple-

ment of labor called for in the payroll standard, (2) this labor force operates the full number of spindle hours it has been determined to be capable of operating, and (3) for each spindle hour operated, whatever the yarn size being produced, the production achieved was the expected or standard amount for that yarn size. These are the standard conditions we shall try to maintain, for only by maintaining these or better conditions will our actual unit costs equal or be lower than the standard unit costs.

Payroll Analysis

The starting point in developing the standard labor costs for any department or process is the analysis of the payroll or budget of the labor serving that department or process. Exhibit 1 shows

PAYROLL ANALYSIS—SPINNING DEPARTMENT

Classification	*Number employed*	*Rate per hour*	*Total amt.*	*Spindle basis*	*Pound basis*	*Direct basis*
Overseer	½	—	$ 37.50	$ 37.50		
Section men	2	$ .93	74.40	74.40		
Timekeeper	½	.805	16.10	16.10		
Oilers	2	.745	59.60	59.60		
Overhauler	½	1.00	20.00	20.00		
Traveller changer	½	.735	14.90	14.90		
Cleaners	4	.72	115.20	115.20		
Roll pickers	2	.72	57.60	57.60		
Sweepers	1	.67	26.80	26.80		
Roving men	3	.72	86.40		$ 86.40	
Bobbin machine man	1	.72	28.80		28.80	
Spinners	16	p/w .83	531.20			$531.20
Doffers	10	p/w .86	344.00			344.00
Totals	43		$1,412.50	$422.10	$115.20	$875.20

Spindle Basis Labor Cost Distribution:

$$\frac{\$422.10}{24{,}992 \text{ spindles in place} \times 40 \text{ hours}} = .0422¢ \text{ Standard cost per spindle hour}$$

Pound Basis Labor Cost Distribution:

$$\frac{\$115.20}{45{,}000 \text{ normal pounds per } 40 \text{ hours}} = .2560¢ \text{ Standard cost per pound}$$

EXHIBIT 1

the payroll analysis and distribution for a spinning department. In the first column are listed the various classifications of labor required. Next, opposite each classification is shown the number of persons of that classification required to operate all of the ac-

tive machinery in the department at standard efficiency (or standard output per spindle hour) for one forty-hour shift. The decision as to how many persons of each classification are required should be reached only after careful job measurement studies. It will be noticed that one-half overseer is shown. Since the spinning department is scheduled for two-shift operation, with one overseer supervising both shifts, only one-half of the overseer's time and pay is charged against each forty-hour shift. The next column gives the hourly rates applicable for each labor classification, and the following one gives the total amount which would result from the employment of the prescribed number of employees paid at the prescribed rates. The total of the total amount column, then, is the standard, or budgeted, payroll.

Importance of Labor Allocation

The total of the labor budget for one forty-hour shift is next allocated to the units of production (pounds of yarn in this instance) which the given labor force is expected to produce in one forty-hour shift. If all yarns were the same size and all spinning frames were exactly alike, we would merely divide the $1,412.50 by the number of pounds of yarn expected from forty hours of operation. But all yarns and spinning frames are not alike. There are two types of spinning frames and the yarn numbers run from 17s to 39s. Even if we arrive at a total number of pounds of yarn of all sizes to be expected in forty hours of operation, based upon a given layout or proportion of the various yarn numbers, an average per pound cost obtained by dividing the $1,412.50 by these pounds would mean nothing, for obviously it has taken more labor to produce a pound of 39s than it has to produce a pound of the coarse 17s. If we do not secure an apportionment, or distribution, of the labor cost which accurately reflects the incidence of the labor we may be showing the per pound cost for the 39s at more than it properly should be and the cost for the 17s at less than it should be. Were we to use the undercosted figure for the 17s in arriving at a total fabric cost for a style woven from 17s yarn, we would have a total fabric cost which underestimated our cost to produce the style. If the margin between our sales prices on the style and our too-low cost figure indicated a relatively high profit and we took large orders on this basis, we would be sadly misled. On the other hand, if we failed to take orders for styles requiring 39s

yarn because our too-high cost figure made the profit margin seem too low, we would also be in error. The use of inaccurate cost figures can often be worse than having no cost figures at all.

The Spindle Hour

We are now ready for the next step leading to the final distribution of the cost to the individual yarn sizes. The distribution base generally chosen for all spinning room labor, except the directly-costed piece-work spinners and doffers, is the spindle hour. For forty hours of operation the 24,992 active spindles in the department would run 40 x 24,992, or 999,680 spindle hours. If, then, all labor except spinners and doffers, amounting to $537.30, were divided by 999,680 spindle hours it would yield .0537 cents as the standard labor cost to operate one spindle one hour. This theory assumes that all the labor thus distributed is a function of the spindle hours run, that the amount of payroll money spent for these classifications of labor should vary in direct proportion to the spindle hours operated. It assumes that the same amount of these types of labor will be required to operate a spindle hour on 39s yarn as on 17s yarn. This is true for most but not all labor. For example, the oiler must contribute the same amount of his time to operate a spindle hour on 17s as on 39s, for he is required to oil the frames at given time intervals regardless of what yarn is being run. Similarly, the sweeper must sweep around the frames from time to time, the frequency of the trips having no relation to the yarn size being run.

The Pound Basis

However, in the case of the roving layer, a spindle hour on 17s will produce more yarn poundage than a spindle hour on 39s. Since the roving layer's job consists of transporting the roving to the frames and laying it up, a pound of roving is a pound of roving to him, regardless of whether it happens to be 2.00 hank or 3.50 hank, and regardless of what yarn is being spun from it. Therefore, it may readily be seen that the roving layer's job does not vary with the spindle hours run, but rather with the pounds of roving he has to handle. Similarly, the bobbin machine man's job will vary with the pounds and not with the spindle hours. It follows that any cost distribution which includes the pound-handling labor with the spindle-hour labor will not give a proper appor-

tionment of the cost, since it will result in the same charge per spindle hour for the pound-handling labor, regardless of the yarn size. It is apparent that a spindle hour's operation on 17s requires more than twice as much roving laying as a spindle hour's operation on 39s, and hence more than twice the amount of labor should be charged for the operation; otherwise the 17s are undercosted and the 39s are overcosted. Reference to Exhibit 1 indicates that in the labor distribution illustrated, a distinction has been made between the spindle basis labor and the pound basis labor, the distributions being made to separate columns. These columnar totals are divided respectively by the spindle hours expected to be run and the normal number of pounds expected to be handled by the labor so distributed, resulting in standard costs of .0422 cents per spindle hour and .2560 cents per pound.

We have now accomplished the preliminary distribution of all of the manufacturing labor in the spinning department except the piece-work spinners and doffers. This distribution offers the simplest sort of costing, for we have only to divide the piece-work rate by the number of pounds represented by the piece. We then have the standard cost per pound for spinners or doffers.

Labor Standards Illustrated

Now we are ready to assemble total spinning room labor cost per pound for each yarn number on each type frame. To illustrate the method, we shall develop the cost for 17s filling, 3.76 twist multiplier, being run on a 240-spindle frame, 1 7/16" rings, at a front roll speed of 190 rpm. Standard efficiency has been set at 89.06 per cent. The total cost will be the sum of the four elements representing the different cost distributions which we have employed, i.e., the spindle basis labor, the pound basis labor, the spinner, and the doffer.

First, we must calculate the standard pounds per spindle hour; i.e., the weight of 17s yarn we should get from one spindle hour's operation, with the front roll speed 190 rpm and the efficiency being 89.06 per cent. The factor to be used to allow for contraction of yarn due to twisting is .9509:

$$\frac{190 \text{ rpm} \times 1'' \text{ f. r.} \times 3.1416 \times 60 \text{ mins.} \times .8906 \text{ eff.} \times .9509 \text{ contr.}}{840 \text{ yds. per hank} \times 36 \text{ ins. per yd.} \times 17\text{s yard}}$$

$$= .0590 \text{ standard pounds per spindle hour.}$$

Since for spindle basis labor we expect a cost of .0422 cents per spindle hour, and since in one spindle hour we expect to produce .0590 pounds:

$$\frac{.0422¢}{.0590} = .7153¢ \text{ standard cost per pound} = \text{spindle basis.}$$

We already have the pound basis labor expressed in terms of cost per pound, i,e., .2560 cents per pound regardless of yarn size. The spinner's piece-work rate per frame hank is 17.25 cents. A frame hank of 17s on a 240-spindle frame will weigh 13.42 pounds (240 x .9509 contraction factor divided by 17). Dividing 17.25 cents by 13.42, we get 1.2854 cents as the spinner's cost per pound. Similarly, the doffer's 8.60 cents per side hank divided by 6.71 pounds per side hank gives 1.2817 cents as the doffer's cost per pound.

Summarizing all four labor costs:

.7153¢ per pound	= spindle basis labor
.2560¢ per pound	= pound basis labor
1.2854¢ per pound	= spinners
1.2817¢ per pound	= doffers
3.5384¢ per pound	= total standard labor cost

Following the same pattern, standard costs may be arrived at for each yarn number on each type of spinning frame.

Comparing Actual and Standard Costs

But merely finding the standard costs is not carrying the matter far enough, for our standard costs are only the costs at which we hope to be able to produce. We must constantly measure our success in operating within our standard or budgeted costs, so that we may know what adjustments must be made to our standards in order to reflect properly current actual costs. Also, since our standard costs are based upon good operating conditions, not impossible of attainment, which we are striving to meet or to better, we have a yardstick against which we can measure our actual performances and gauge our shortcomings and merits. By analyzing these variations from the yardstick we can uncover both the place of departure from the standards and the general reasons therefor. Knowing where our costs are too high and what is causing them to be too high, we are at least intelligently prepared to approach the problem of doing something about it.

The method generally employed in measuring actual labor costs against standard labor costs is the weekly comparison of the actual payroll with the standard payroll. First, a production report showing the total pounds of each yarn size (continuing with the spinning department illustration) produced during the week is obtained. Every spinning room has this information available in one form or another. The actual pounds produced of each size are then multiplied by the appropriate standard labor costs to obtain the standard payroll, or the amount the payroll should have been for the production actually achieved if each unit actually had been produced at the standard labor cost. For example, assume that the following production report shows the pounds of the various sizes which were produced in the spinning department for the week ending July 5, 1947:

Yarn size	*Lbs. actually produced*	*Standard labor cost/lb.*	*Total standard labor cost*
17s	53,978	3.5384¢	$1,909.96
23½s	8,483	4.0201¢	341.03
25s	5,394	4.2654¢	230.08
27s	12,740	4.5202¢	575.87
29s	11,702	4.8170¢	563.69
39s	3,115	7.2659¢	226.33
Total	95,412		$3,846.96

Assuming that the actual spinning room payroll for the week was $4,147.02, we then divide the actual payroll by the standard payroll and obtain ratio of 1.078, meaning that for each labor dollar we should have spent we actually spent $1.078. This ratio is intended to indicate the cost trend. Periodic follow-up of the comparison must be made with a complete analysis and breakdown of the actual and standard payroll amounts. Such an analysis must go into great detail and its exact methods are too involved for minute coverage here; however, a brief explanation of the methods and purposes will suffice.

It should be apparent that the $3,846.96 standard payroll can be easily broken down into the various labor classifications from which it was originally derived, so as to give us the standard payroll amount we should have spent for each category—oilers, roving layers, etc.—based upon the production actually achieved. By comparing these standard amounts for each type labor with the actual amounts paid on the payroll for the corresponding types of

labor, we can spot exactly which labor classification is being used to too great or too small an extent. It is desirable, too, to spot the savings, so that the reasons therefor may be made available for the benefit of all concerned; or to determine whether the savings may have been made on cleaners, or on some other classification where skimping is not desirable and would lead to bad work in some later process.

Labor Efficiency

The use of efficiency data (from a report to be discussed subsequently) enables us in our analysis to arrive at the labor gain or loss which is due purely to efficiency. For example, the efficiency report shows that the spinning department has operated at 98 per cent of standard efficiency for the week, that is, for the spindle hours run we have produced only 98 per cent of the pounds we should have produced. With the same labor force as we used, we should have produced one hundred pounds for each ninety-eight pounds we did produce in the same length of time. The standard spindle basis labor cost for those two pounds out of each one hundred pounds is a loss to us, because we paid the spindle basis labor for one hundred pounds but only received ninety-eight.

By such methods as those described above, we are able to explain in minute detail exactly what gains and losses went to make up the difference of $300.06 between the actual payroll of $4,147.02 and the standard payroll of $3,846.96. We can find the amount of gain or loss due purely to high or low output per spindle hour, and the gain or loss due purely to having too few or too many people at work and show exactly which labor classifications are involved.

Production Report

We have referred to the necessity of obtaining a production report from the departments showing the total number of units of each type or style produced during a given period. This is necessary from a cost standpoint so that the standard labor costs may be applied to the actual production to arrive at the standard payroll, as illustrated above. Accurate production reports, of course, are indispensable to management for production control, scheduling, and other purposes.

Exhibit 2 shows a suggested form for a production and efficiency report for a spinning department. All mills secure some

sort of data on efficiency, and because of the relation of efficiency to unit cost, a close check on the relative efficiencies of the various yarn sizes, for example, is highly desirable. By knowing which yarns are responsible for the poor efficiency showing, we know where our corrective efforts should be made.

Standard vs. Actual Efficiency

In Exhibit 2, opposite each yarn size are the specifications as to twist, spindles per frame, ring size, and front roll speed (Cols. 1-5). The next column (Col. 6) shows the actual number of frame hanks produced of each yarn specification. These frame hanks are multiplied by the pounds per frame hank (Col. 7) and the result is the actual pounds produced (Col. 8). Column 9 shows the spindle hours actually operated in producing the pounds shown in column 8. By dividing the actual pounds (Col. 8) by the standard pounds per spindle hour (Col. 10), we obtain the spindle hours required at standard efficiency (Col. 11), or the number of spindle hours it should have taken to produce the actual pounds, if our output per spindle hour had been at the standard or expected rate. Dividing the spindle hours required at standard efficiency (Col. 11) by the actual spindle hours (Col. 9), we obtain the per cent of standard efficiency achieved (Col. 12), or how close we came to meeting the per cent efficiency at which we were aiming. This figure should not be confused with "actual efficiency." The former relates actual efficiency to standard efficiency, so as to offer in one figure, and with no mental slide-rule gymnastics on the part of the reader, an index as to the efficiency of the performance relative to the standard or expected performance. For example, on 17s yarn standard efficiency has been figured at 89.06 per cent, that is, taking into consideration the front roll speed, the frequency of the doffing, and the length of time the frame should be stopped for doffing, it has been figured that to keep the machine operating 89.06 per cent of the time is as good a performance as can reasonably be expected. This is the standard efficiency which we try to achieve; it is a yardstick against which we measure actual efficiency. On the other hand, standard efficiency for 39s has been set at 97.48 per cent. Thus, if in a given week we learn that the 17s and the 39s each ran at 90 per cent actual efficiency, we must mentally relate 90 per cent to 89.06 per cent for the 17s and 90 per cent to 97.48 per cent for the 39s to arrive at the conclusion that the 17s ran at better than expected efficiency while the 39s

turned in a somewhat less than good performance. By calculating the per cent of standard efficiency achieved in one operation, the clerical effort in arriving at the one indicative percentage is reduced greatly over other methods.

It should also be noted that by dividing the total spindle hours required at standard for the whole department by actual spindle hours for the whole department, we get a per cent of standard efficiency which accurately reflects the whole department's achievement in making the expected output for its total hours of operation.

In order that the production and efficiency data on each yarn, from week to week, may be made available in one place, a set of cards should be prepared, one for each yarn, and posted weekly with the actual pounds, actual spindle hours run, and per cent of standard efficiency for each yarn. Reference to these cards will give the management information as to the week-to-week trend of production and efficiency, not only by yarn sizes but also by

PRODUCTION RECORD CARD

Yarn No. 17s Fill. Spdls frame 240
Twist mult. 3.76 Ring size 1-7/16"
Front roll speed 190 Std. lbs./Sp. hr. .0590
Std. % effcy. 89.06%

Cost per pound

Indirect-Sp Basis	.7153¢
Indirect-Lb Basis	.2560
Direct-Spinners	1.2854
Direct-Doffers	1.2817
Total	3.5384¢

W/E	Sp. hrs. run	Lbs. prod.	% Std. eff.	W/E	Sp. hrs. run	Lbs. prod.	% Std. eff.
4 Jan	783,775	45,030	97.4	5 Jul	914,672	53,978	100.0
11 Jan	865,260	50,984	99.9	12 Jul	752,634	44,982	101.3
18 Jan	879,844	51,235	98.7	19 Jul	683,176	40,882	101.4
25 Jan	763,765	45,468	100.9	26 Jul	639,209	38,458	102.0

EXHIBIT 3

departments. Exhibit 3 illustrates a suggested form for a production record card. Notice that the heading gives the yarn size and other distinguishing specifications. Also, the right-hand side of the heading provides space where the standard labor costs per pound for that particular yarn are posted. This facilitates the calculation of the total standard payroll each week, for it is only a simple clerical operation requiring a few minutes time to multiply the pounds produced during the week as shown on the card times the standard costs appearing in the heading of the card. With an accumulating calculating machine the task is all the more simple.

SPINNING PRODUCTION REPORT

Week Ending July 5, 1946

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Yarn size	*Twist mult.*	*Sp/ fr.*	*Ring size*	*F.R.S.*	*Fr. hanks produced*	*Lbs./ fr. hk.*	*Pounds produced*	*Actual sp. hrs. run*	*Std. lbs./ sp. hr.*	*Spd. hrs. at std. eff.*	*% std. eff.*
17s	3.76	240	1-7/16"	190	4022.2	13.42	53,978	914,672	.0590	914,881	100.0
23½s	3.76	240	1-7/16"	162	873.6	9.71	8,483	229,123	.0379	223,826	97.7
25s	3.79	224	1-5/16"	150	633.8	8.51	5,394	172,000	.0333	161,982	94.2
27s	3.72	224	1-5/16"	145	1612.7	7.90	12,740	430,000	.0302	421,854	98.1
29s	3.83	224	1-5/16"	143	1596.5	7.33	11,702	425,134	.0277	422,455	99.4
39s	4.21	224	1-5/16"	112	578.0	5.39	3,115	212,247	.0163	191,104	90.0
Totals							95,412	2,383,176		2,336,102	98.0

EXHIBIT 2

Conclusion

This discussion has attempted to describe briefly some of the purposes and methods of cost accounting in a cotton textile mill, through the medium of a general introduction and a somewhat detailed description of the development of standard spinning department labor costs and of some of the uses to be made of these costs once found. It should be pointed out that while the illustration is rather detailed, it purposely assumes an extraordinarily simple situation, and many complicating factors which are bound to be encountered in actual practice have not been shown.

Today, more than ever before, many mills are introducing for the first time a program of cost and standards control or augmenting one already started. A few pioneering manufacturers attribute a considerable degree of success to their programs which point the way. The decision to begin this work and the beginning of it do not necessarily mean that results will follow immediately. As required in obtaining anything of value, there must be expenditures of time, effort, and money before results are noticeable; and these efforts must not cease if good results are to be maintained.

COMING ARTICLES

In the *N. A. C. A. Bulletin*, October 15, 1947

Better Rates Through Element Time Standards
by W. R. Wright

Controlling Material Supply and Inventories
by B. W. Kinderman

Cost Control for Motor Carrier Operations
by Allen C. Kahl

Control Procedures for Special Operating Supplies
by John R. Haas

COST PROBLEMS FOR WEST COAST ALUMINUM

by LEONARD A. DOYLE,
Director of Economic Research,
Permanente Metals Corp.,
Oakland, Calif.

IN THE SPRING of 1946 Henry J. Kaiser got into the aluminum business by leasing from the War Assets Administration the only aluminum rolling mill in the west, at Spokane, Washington, and the largest aluminum reduction plant in the Pacific Northwest at Spokane. Subsequently an alumina plant at Baton Rouge, Louisiana, was leased, a reduction plant at Tacoma, Washington, was purchased, and a soda ash plant constructed at Owens Lake, California, It is an interesting development that the organization that built Bonneville and Coulee Dams ten years ago should now be operating plants which depend on these dams for the vast amount of electric power that is the key to the aluminum industry.

Size of Industry

Before discussing the cost accounting problems of an aluminum manufacturer, a review of the present structure of the industry, particularly the influence of the war expansion, may be helpful to the reader. At the end of 1946 the aluminum ingot capacity of the United States was 883,000 tons, of which about 650,000 tons is economical capacity at present prices for metal and power. Of the economical capacity 51 per cent is owned by the Aluminum Company of America, 29 per cent owned or leased by Reynolds Metal Company, and 20 per cent owned or leased by Permanente Metals Corporation. Of the national economical capacity of 650,000 tons about 317,000 tons or nearly half the national capacity is located in the Pacific Northwest. North America now has over 65 per cent of the primary aluminum capacity of the world, the United States having about 40 per cent of the world capacity of aluminum and Canada 26 per cent.

At the end of the war, the prospects for the aluminum industry looked anything but bright, for reduction capacity was five times the 1939 market volume. To make matters much worse, an estimated three billion pounds of metal was on hand in the form of potential aircraft scrap, government stockpiles, and metal on hand or in process when cancellations of war contracts started. The

three billion pounds of metal on hand alone was ten times the 1939 market for primary aluminum. During the war an extensive study of the postwar market for aluminum was made which indicated a possible market would be reached for one billion pounds of primary at the end of five years after the war, if the price were 12 cents (a 20 per cent reduction in price), and a market for 600 million pounds of secondary ingot at a price of six to eight cents per pound.

What happened to the industry in the first postwar year of 1946? The light metals age which arrived with the war continued into peacetime production. By the last quarter of 1946 aluminum ingot and scrap were in such short supply that the price of secondary ingot rose above that of primary. Total shipments for the first postwar year, when the government plants operated only six months, were over 1,500 million pounds. Although 1946 was a big year for aluminum, it is unwise to judge the future by the immediate past, for the industry undoubtedly secured a large amount of business by virtue of the shortage of steel and lumber and the substantial increase in the price of copper after the removal of OPA. How much of the 1946 market was substitution and how much real demand is now the question.

Whatever the future of aluminum, the cost accounting problems have been and will continue to be varied and complex. In large measure, the problems arise from the vertical integration of the industry and the tremendous variety of products at the fabricating end. There are now three vertically integrated companies in the industry: The Aluminum Company of America, Reynolds Metals Company, and the Permanente Metals Corporation (Kaiser). Although vertical integration exists, the companies do not consume all of the output of the plants as the product passes from one stage to another. Depending upon the balance between pig capacity and fabricating capacity, a varying percentage of each company's pig production will be used by its fabricating plants—and at all times management must decide how much, if any, scrap it will buy to mix with primary metal.

Basic Factors

A company entering an industry on a large scale by leasing plants has one primary requisite for its cost accounting system—speed. Costs and profit margins must be known quickly and in considerable detail. All top management officials of the Perma-

nente Metals Corporation agreed that it would be unwise to make any attempt to develop a standard cost system during the initial period of operation, but that instead it would be desirable to have detailed costs on an actual basis, provided that the costs would be available quickly. We believe that the system used by this company is quite effective in that each plant has its cost statement and profit and loss statement in the mail to the home office and its trial balance on the teletype at the end of seven working days after the close of the month, and the home office has a consolidated statement complete with supporting schedules, graphs, and an interpretive analysis in three additional days.

The fact that a varying percentage of pig aluminum would be consumed by the company's own fabricating plant made it desirable to maintain accounting records in such a way that each plant has considerable autonomy in its own operation, but that top management also is able to determine when to alter the metal consumption program of the fabricating plants in order to make the best utilization of the reduction (primary metal) facilities. To achieve these ends and also to permit evaluation of the operating results of each plant, accounts for each producing plant are kept on a market price basis for purchase of raw material and sale of finished products. In working out cost systems for the various plants, an effort was made to provide costs which could be analyzed at periodic intervals on the basis of economic theory. The modern economic theory of the behavior of the individual concern deals with two chief problems:

1. How the various factors of production, material, labor, and plant facilities should be combined to get the lowest cost technically possible for a desired level of output, and
2. The determination of the most profitable combination of selling price and output under given market conditions.

Treatment of Fixed Costs

In each of these analyses, economists believe that fixed costs in general, and noncash fixed costs, such as depreciation and amortization, in particular, are irrelevant to the solution of the problems. Although fixed costs are ignored by economists in short-run analyses, they cannot be ignored by the accountant. Our solution to the problem, for the plants of such size that the problem warrants, is to make fixed costs directly variable in relation to oper-

ating time at the rolling mill and to output at other plants. Thus taxes, insurance, amortization of certain deferred charges, etc., for the rolling mill are budgeted for the fiscal year and then converted to an hourly rate by dividing the total fixed charges by the number of hours each production center is to be used in securing the production budgeted through that center for that plant for the year. For reasons of conservatism, the classification of fixed expenses was kept to a minimum the first year, and other overhead costs were classed as variable costs and absorbed in production each month. A statistical analysis is being made of the various items of variable cost for the first nine months to see how each is correlated with operating time. Such costs as are found to be relatively fixed will be transferred to the fixed category and a budget prepared of both fixed and variable costs for the next year. This budget will enable us to check on those costs which are a function of time, and to compute more accurately the break-even point of each plant and of the integrated operation.

Accounting for the Production of Alumina

The first stage in the production of aluminum is the mining of bauxite. Although aluminum is one of the most plentiful elements in the earth's crust, the cost to isolate it is prohibitive unless it is present in large quantity in bauxite ore containing 56 to 60 per cent aluminum oxide and not over seven per cent silica, about 30 per cent chemically combined water, and small amounts of iron, titanium, and other impurities. Most bauxite is mined by the open-pit technique, and the great majority of the ore used in normal times in the United States is imported, chiefly from Dutch Guiana. High grade domestic reserves exist in Arkansas but are limited in quantity.

Method of Manufacture

Bauxite when received at the alumina plant at Baton Rouge looks like red clay. The first process is grinding the bauxite. The second process is digestion in which caustic soda unites with the alumina content of the bauxite to form sodium aluminate. The iron, silicate, and other impurities, as well as a certain quantity of alumina and caustic soda, are filtered out as red mud in the third process. The aluminate continues to precipitating tanks where it is mixed with a "seed" charge of alumina hydrate from a previous cycle. Under agitation and slow cooling, crystallized aluminum

hydrate is put through rotary kilns at high temperatures to eliminate the chemically combined water. The end product, alumina, is a fine white powder which looks something like cement. It is shipped in box cars to Spokane in trainload lots. At Baton Rouge a process cost system is employed which gives material, labor, and overhead in total and the unit cost for every operation. The cost statements show costs for the current month, prior month, and year to date. The major emphasis in the process is to use ore with the proper percentage of aluminum and silica; hence the cost accounting problem is to measure the effect of variation in raw material on unit cost.

Problem of Soda Ash

A cost problem peculiar to a new firm exists at Baton Rouge with respect to an important material, soda ash. Soda ash last year was one of the most critically short materials in the country. The supply was adequate for only about 85 per cent of the requirements, and since Permanente was a newcomer, the only way to get soda ash was to make it. A plant was built at Owens Lake, California, in sixty-seven ten-hour shifts and is now in production. The price of soda ash f. o. b. California plants is about six dollars per ton higher than the quoted price at Baton Rouge. The California price plus freight is almost double the Baton Rouge price. To keep the costs of each plant on a market basis, it is necessary to use the California price to determine the profit or loss at Owens Lake, but the southern price is used in the costs of Baton Rouge. The freight plus the difference in price of six dollars, adjusted for profit or loss at Owens Lake, is in effect considered an intracompany loss and is handled in the same way as other gains or losses on intracompany transfers.

Accounting for the Production of Aluminum

The reduction plant at Mead, Washington, outside Spokane, converts powdered alumina to metallic aluminum. There are three separate operations at the Mead plant. The first is the manufacture of carbon electrodes, the second the conversion of A. C. power to D. C., the third the reduction of powdered alumina to metallic aluminum. The plant consists of six pot lines, and can utilize any number from one to six, although once a line is started it is expensive to shut it down and start it again. The bulk of a reduction plant consists of long buildings with silos in between, two

buildings comprising a pot line. In each building there are 64 pots, or 128 to a line. Each pot is lined with carbon paste which forms one of the electrodes. In each pot there is a molten bath of cryolite, to which are added varying amounts of aluminum fluoride, fluorspar, and soda ash. Alumina is unloaded from box cars by a giant vacuum cleaner arrangement and taken by conveyor belt to the storage silos, from which it is fed by gravity to the pots. The alumina is introduced into the molten bath and electric current is passed through the bath. As current passes through copper busbars to carbon electrodes, the oxygen from the aluminum oxide (alumina) is deposited at the anodes and metallic aluminum is deposited at the bottom of the pot. Each pot is tapped by a siphon process at approximately 64-hour intervals, and the molten aluminum cast into fifty pound pigs.

Material Cost Problems

Exhibit 1 is a cost statement showing the computation of the cost of pig aluminum. The figures used are illustrative and not actual. Exhibit 2 shows the computation of the cost of green carbon which is the pressed electrode ready for baking. Exhibit 3 shows the computation of the cost of finished electrodes transferred to the pot rooms. The electrodes are attached to copper bars by pouring an iron core in the carbon block and attaching the rods to the core—all done on an assembly line basis.

One of the major problems in determining the cost of metallic aluminum is that of computing the consumption of raw material. The reader will note on Exhibit 1 that a conversion factor is used in determining the consumption of alumina. It is impractical to weigh the alumina as it is added to the pots, and really not necessary, since there is a constant weight of alumina required to produce a pound of metallic aluminum—1.95 being the factor. As the pigs are cast, they are trucked to a scale and weighed. The tally of weights for the month gives the total production. For technical reasons it is desirable to add certain alloying metals to the bath. Allowing for the conversion in form of ferromanganese and chrome, it is assumed that all alloying material added during the month is incorporated in the weight of the finished product. The net weight of the alloy material is therefore subtracted from the weight of the metal produced to secure the weight of pure aluminum. The aluminum weight is then multiplied by 1.95 to secure the weight of alumina used. The consumption of elec-

THE PERMANENTE METALS CORPORATION
MEAD WORKS

Aluminum Manufacturing Cost
February, 1947

Material	*Weight*	*Amount*	*Unit per lb. alum.*
Alumina (195%)	26,084,941	$ 784,670.40	.0572
Conversion (95%)	12,708,048		
Net production (100%)	13,376,893	$ 784,670.40	.0572*
Alloys			
Copper	182,124	22,219.13	.0016
Iron	18,680		
Ferro-Manganese	129,242	13,311.93	.0010
Conversion Ferro-Manganese	(9,728)	1,001.98	.0001
Chromium	11,075	2,990.25	.0002
Conversion credit	(5,455)	1,472.85	.0001
Gross production	13,718,014	$825,666.54	.0602
Electrolytes			
Cryolite (syn)			
Kryolith			
Aluminum fluoride	(355,575)	$36,268.65	.0026
Fluorspar	(44,380)	1,065.12	.0001
Soda ash			
Reclaimed bath			
Rutile			
Electrodes	(8,695,355)	175,590.58	.0128
Butt credit	(1,386,738)	(11,787.27)	(.0008)
Total material	13,718,014	$1,026,803.62	.0749
Power		310,027.52	.0226
Labor		244,180.65	.0178
Burden—Reserve for potlining		35,840.00	.0026
—Other burden		155,013.56	.0113
Amortization for kryolith		10,572.80	.0008
Cost of production	13,718,014	$1,782,438.15	.1300

$$*\frac{784,670.40}{13,718.014} = 0.572$$

EXHIBIT 1

trolytes, those materials added to the bath, is the weight of material actually added to the bath during the month. When production was started, the War Assets Administration placed the pot lines in condition to operate and furnish the normal amount of bath material. It was found, however, that a large quantity of bath material was absorbed in the lining of the pots in the first

MEAD WORKS
Green Carbon Manufacturing Costs
February, 1947

	Per cent	Price	Tons	Cost per ton	Amount
Materials:					
Green coke	33.7	$15.86	1,646.2	$ 5.648	$ 26,108
Less baking loss....	5.5		267.6		
Net green coke...	28.2	$15.86	1,378.6	$ 5.648	$ 26,108
Calcined coke	36.4	28.42	1,779.8	10.943	50,582
H. S. P. pitch	15.5	25.39	758.8	4.168	19,266
Butts	14.4	18.70	705.2	2.853	13,187
Net material	94.5		4,622.4	$23.612	$109,143
Operating costs:					
Labor					
Inside storage				$ .155	$ 716
Coke baking				.124	573
Grinding				.166	767
Mixing				.148	684
Pressing				.222	1,026
Total labor				$ .815	$ 3,767
Burden					
Inside storage				$ .532	$ 2,459
Coke baking				.431	1,992
Grinding				1.113	5,145
Mixing				1.870	8,644
Pressing				.952	4,401
Total burden...				$ 4.898	$ 22,641
Total operating cost.....				$ 5.713	$ 26,408
Green carbon cost,.....			4,622.4	$29.325	$135,551

EXHIBIT 2

month of operation. This is considered a deferred charge to be absorbed over the normal life of a pot lining. Because of the lease arrangement the company is in the peculiar position of having to establish a reserve to reline the pots with carbon at the same time that it is amortizing the cost of the bath material absorbed in the new lining—hence the two apparently contradictory items of cost at the bottom of Exhibit 1. The unit costs on Exhibit 1 are all obtained by dividing the total cost for each item by the total pounds produced.

Marginal Costs of Metal

The cost data developed on Exhibit 1 permit the application of the economic analysis mentioned earlier in connection with the determination of the proper combination of the factors of production. The general theoretical solution of this problem is that each element of cost should be increased if the marginal revenue resulting therefrom exceeds the marginal cost—a complicated way of saying you do it if it pays. In general, the production of one pound of aluminum requires the consumption of from 8 to 10 kw.h. of electric current. It is possible, therefore, to vary the amount of power sent through the pots and thereby vary the pro-

MEAD WORKS

Finished Carbon Manufacturing Costs

	Per cent	*Price*	*Tons*	*Cost per ton*	*Amount*
Materials:					
Green carbon	100.0	$29.591	4,778.7		$141,407
Less baking loss ...	7.5		357.3		
Scrap credit	1.3	18.700	64.4		1,204
Net material	91.2		4,357.0	$32.179	$140,203
Operating cost:					
Labor					
Carbon baking ...				$ 1.773	$ 7,725
Cleaning				.189	823
Fuel oil				.128	558
Total labor				$ 2.090	$ 9,106
Burden					
Carbon baking ...				$ 2.132	$ 9,289
Cleaning				.530	2,309
Fuel oil				1.722	7,503
Total burden ..				$ 4.384	$19,101
Total					
Carbon baking ...				$ 3.905	$17,014
Cleaning				.719	3,133
Fuel oil				1.850	8,060
Total operating.				$ 6.474	$28,207
Finished carbon cost....			4,357.0	$38.653	$168,410

EXHIBIT 3

duction of metal in a given time period. Exhibit 4 is an application of the marginal analysis in determining the profitability of increased use of power. Although the figures for the elements of cost on the statements are not actual costs, the cost differentials on the statement are actual,

February costs for power, labor, and overhead exceeded those of January by twelve cents per pound. Analysis disclosed that power costs went up by fifteen cents, whereas the costs of labor and overhead were down three cents. Production was less in February, but of course this might have been due to the shorter month. Since production of aluminum is continuous, twenty-four hours a day seven days a week, it is possible to compare February production with January on a per-day basis. This was done by converting January to a daily basis and multiplying by 28 to secure February production at the January rate. Comparison of the two figures reveals that February production exceeded January by 489,862 pounds which, at the market price of 14 cents, was worth $68,581. The net increase in cost of power, labor, and overhead resulted from a higher power consumption per pound of metal and hence, if this paid, it should be charged to the added output. Subtracting the additional cost of February production—13,718,014 times .12 cents or $16,462—from the value of the added (marginal) output leaves $52,129 which, divided by the marginal output of 489,862, gives a gross marginal revenue of 10.64 cents per pound. If January costs were less than 10.64 cents per pound, it paid to use the additional power. If they were more than 10.64 cents, the use of power was unprofitable, i.e., it yielded less in marginal revenue than the marginal cost. If January costs were exactly 10.64 cents, no change would have occurred. Proof of these propositions is shown at the bottom of Exhibit 4. The important thing to keep in mind about this analysis is that it is valid only if fixed costs are made variable by the use of a predetermined rate, or if they are so small that they can be ignored. In the case of Mead, and all of our leased plants, we do not show rentals in plant costs. In order to permit the marginal analysis, rentals are carried on the home office books only.

Accounting for the Rolling Mill Operation

Of the plants which Permanente Metals operates, the rolling mill at Spokane is by far the largest in physical size. The accounting problems are as complex and as large as the plant. The

ANALYSIS OF PROFIT OR LOSS FROM TECHNICAL CHANGE

January production in pounds	14,645,464
Average per day in pounds	472,434
February production in pounds—actual	13,718,014
February production in pounds—at January rate	13,228,152
Increase in production due to technical change	489,862
Value of additional (marginal) output at 14¢ per lb.	68,581

Computation of Additional (marginal) Cost of Added Production

	January	*February*	*Increase (Decrease)*
Electric power—$ per pound	$.0211	$.0226	$.0015
Labor and overhead—$ per pound	.0328	.0325	(.0003)
Total	$.0539	$.0551	$.0012

Increased (marginal) cost attributable to higher consumption of power—13,718,014 x .0012	$16,462
Value of additional (marginal) output	68,581
Gross revenue from marginal output	$52,129
Gross revenue per pound of marginal output $52,192 ÷ 489.862	$.1064*

*If average cost per pound in January was less than $.1064, the technical change was profitable; proof as follows:

	Feb. actual	*Feb. at Jan. rate*	*Difference*
Production in pounds	13,718,014	13,228,152	489,862
Sales value of production at 14¢	1,920,522	1,851,941	68,581
Cost of production—February .0012 over January: If January at .1064 & February at .1076	1,476,057	1,407,476	68,581
If January at .1288 & February at .1300	1,783,342	1,703,786	79,556
If January at .0964 & February at .0976	1,299,778	1,275,194	24,584

EXHIBIT 4

mill itself covers fifty-three acres under one roof, cost over $47 million, and is capable of handling the entire national ingot output of 1939.

Although the industry has been described in terms of the physical flow of material, Permanente actually started at the last op-

eration and worked back. Trentwood started with pig from the Metals Reserve stockpile and purchased scrap. The reduction plant at Mead produced the first metal in August, using alumina purchased from Alcoa and Reynolds, and the Baton Rouge plant started in November, using bauxite from Alcoa's mines in Dutch Guiana. Starting the rolling mill first meant that we had to solve the biggest accounting problems first.

Ingot Cost

The operations at the Trentwood mill are of three chief types: remelting pig ingot and mixing it with scrap and alloying material and casting it into ingots weighing about 3,300 pounds; rolling the ingots to gauge; and finishing and shipping. At the present time there are five major alloys manufactured. The alloys have various properties of strength and hardness. Each alloy can be produced in several tempers, the temper being produced in the rolling and heat treating operations. The first stage, producing ingots, is concerned only with the desired alloy. Exhibit 5 shows the cost of producing 2S ingots for rolling. The variety of raw material used presents some problems in interpreting variations in ingot cost, for the percentage of scrap influences both the yield and furnace time. After securing the cost of metal charged into the furnace, it is necessary to give credit for scrap. There are two kinds of furnace scrap, clean and dirty. Clean scrap can be charged into the furnace again with little additional cost except for sawing. Clean scrap consists of butts from casting and ingots which are off-analysis or cracked. Dirty scrap consists of splatters from pouring and similar contaminated metal. A careful check is maintained on the percentage of clean scrap. If it is high it means the charge is wrong if ingots are off-analysis, or the furnace operation is wrong if ingots are cracking.

Scrap Value

The value of scrap is considered to be the cost of metal charged less the cost of conditioning the scrap. The credit value is less for dirty scrap because it has to be run through a ball mill and a reclamation furnace to reappear as reclaimed scrap ingot. The skimmings from the furnace are valued at their estimated metal content, but no credit is given for the weight—this being a part of the melt loss. The reason for this is that a substantial part of the weight is ash from the furnace and if the weight of skim is con-

THE PERMANENTE METALS CORPORATION
TRENTWOOD WORKS

Cost of Manufacturing 2S Alloy

Metals Charged	*Quantity*	*Unit*	*Amount*
Purchased Pig 5A	179,079	$.14515	$ 25,993.32
Purchased Pig 4A	331,200	.14436	47,977.02
Purchased Pig 3A	220,284	.14340	31,588.73
Purchased Pig 2A	18,629	.14121	2,630.60
Purchased Pig A-E	126,520	.13710	17,345.89
Purchased Pig F-H	7,490	.14337	1,073.84
Purchased Pig I-L	57,721	.14135	8,159.02
Alcan	1,062,995	.14096	149,839.78
Mead Pig A-E	836,033	.13920	116,375.79
Mead Pig F-H	192,117	.14093	27,075.95
Mead Pig I-L	59,179	.14210	8,409.21
Silican Alloy Pig	—	—	—
Titanium Alloy Pig	—	—	—
Alloy Copper	1,520	.12309	187.10
Al. Foil (Pill Stock)	123	.42938	52.81
Alloy Titanium	42	.32226	13.53
Alloy Iron	6,943	—	—
Purchased Scrap Mead Pads	338,174	.05833	19,725.69
Sheet Mill Scrap 2S	568,687	.13603	77,357.44
Sheet Mill Scrap 3S	20,923	.14336	2,999.52
Sheet Mill Scrap 99.5	13,923	.13943	1,941.28
Reclaimed Scrap Ingot	72,959	.10000	7,295.90
Clean Furnace Scrap 2S	56,988	.13857	7,896.83
Clean Furnace Scrap 3S	32,534	.14052	4,571.68
Clean Furnace Scrap 99.5	5,615	.14167	795.48
Reserve for Inventory Adjustment	—	—	1,100.25
Metals Charged Cost	4,209,678	$.13312	$560,406.66
Less Scrap Recovered			
Clean Furnace Scrap	88,708	.13750	12,197.35
Dirty Furnace Scrap	21,530	.06000	1,291.80
Net Metals Charged	4,099,440	$.13341	$546,917.51
Melt Loss	20,403	—	—
Net Metals Cost	4,079,037	$.13408	$546,917.51
Direct Labor		.00500	20,395.18
Burden		.01000	40,790.37
Skim		(.00054)	(2,220.72)
Subtotal of Manufacturing Cost	4,079,037	.01447	58,964.83
Total Cost	4,079,037	.14871	605,882.34

Yields	*Pounds*	*Percentage*
Production	4,079,037	96.90
Furnace Scrap	110,238	2.62
Melt Loss	20,403	.48
Total	4,209,678	100.00

EXHIBIT 5

sidered as production, there would actually be a melt gain in some months. Statistical analyses are made of the factors which influence the cost of ingots. It was found that increasing the percentage of scrap, although it brings down the average cost of metal charged, also adds to the furnace time, and hence to labor and overhead, and increases the scrap ratio. As in the case of power at the reduction plant, this presents a nice problem in adjusting the ratio of scrap to primary metal.

Ingot Storage

After the ingots are cast they go into "as-cast ingot" storage. A metal records office is maintained in the plant adjoining the office of the remelt superintendent. Physical inventories of purchased metal, purchased scrap, plant scrap, cast and scalped ingots are maintained here, and it is here that the charge weights are tallied, production and scrap records are maintained, and records of metal received are checked. Daily summaries by alloy are sent to the cost department on metal charged, production, scrap, ingots placed in inventory, ingots scalped, and ingots withdrawn for rolling. Keeping accurate metal records is one of the most difficult jobs in the mill, and it can be done only by having an aggressive and intelligent man who spends most of his time in the plant on a continuous checking tour of scale clerks, receiving clerks, furnaces, ingot storage, etc. Eternal vigilance is the price of good cost records, as well as of liberty!

Reclamation of Scrap

A subsidiary division of the remelt department is the reclamation division, in which purchased scrap and plant scrap which is unfit for direct charge into the remelt furnaces is reclaimed in bay window furnaces and, if necessary, sweetened with primary metal. The problem in costing this operation is to use such a scrap credit as to come out with a reclaimed ingot cost approximately in line with that of a primary ingot—if we reclaim plant scrap—and if we purchase scrap to check on the buying price in relation to secondary ingot.

Rolling Ingots

After the ingots are cast they are usually "scalped" or milled to produce a smooth surface for rolling and placed in soaking pits to

be brought to temperature for rolling. Accounting for the rolling operation is a combination of process and job-order accounting. The production planning department schedules the various alloys through the "hot mill" on the basis of stock orders. Each stock order averages 100,000 pounds or about thirty ingots. Each ingot emerges at the end of the line in coil form. To reach coil form, the ingots first pass through a 120-inch reducing mill, are reheated, and then pass through a 112-inch mill and finally through an 80-inch, five-stand continuous mill, each set of rolls operating at increasing speed until a speed of 900 feet per minute is reached. The ingot rolls out to a length of four to five hundred feet. At the end of the run-out table the sheet is rolled into coils and placed in coil storage. From coil storage it goes through one of three cold rolling mills to be rolled to gauge. This is the end of the rolling process, and the rolls are transferred to lots for finishing to customer specification. It is possible to produce over 3,000 different products in a single month, each being a different alloy, gauge, temper, finish, and size.

Costing by Lot Groups

It would be too much work to keep costs by individual lots, so lot groups were devised. Costs are developed for seven or eight ranges of gauge for each alloy, ignoring variations in temper and size. To do this in the finish mill at each production center, a record is made of the machine hours spent on each lot, and also for each product group. Each day these hours are punched in tabulating cards, so at the end of the month the total machine time for each center is distributed by product groups. Since the time of the operators follows that of the machine, the direct labor is prorated on the basis of machine hours. It is possible to make any analysis required of machine time, either from the completed lot tickets or from the tabulated cards, Tabulating equipment is used for all payroll records at the rolling mill, for machine hours, for warehouse inventory, and for a detailed analysis of sales.

Scrap from Rolling Mill

A peculiarity of an aluminum rolling mill is that the scrap is almost as valuable as primary pig. In spite of the high value of the scrap, it is impractical to secure weights for it at each operation. As a result, scrap is not recognized until a lot is finished.

Each stock order produces as many coils as there were ingots rolled, so each coil is assumed to weigh the same as the average of the ingots—in spite of the scrap in the hot-mill. As the stock orders are broken into lots, the average coil weight is transferred to the lot. When the lot is through inspection it is weighed, and the difference between starting ingot weight for the number of coils finished and the finished weight of the lot is considered as scrap. The completed lots are credited with the base metal value for the weight scrapped, and this value transferred to plant scrap inventory. To avoid the use of simultaneous equations, the metal value is the inventory value of that alloy at the end of the preceding month, less the estimated cost of handling—such as baling or reclaiming. In effect, therefore, the cost of a finished lot represents all the labor and overhead applied in the finish mill, plus the cost transferred from the rolling mill, less the scrap credit.

Costs by Production Centers

The use of heavy machinery at Trentwood means that there are really a lot of separate factories or production centers under one roof. There are approximately fifty production centers for which detailed costs are maintained. The overhead ledgers are so kept that costs for six months are on one page, and each page in effect is a production center cost statement. Variable costs are listed first on the page, followed in order by costs allocated from service departments, costs from plant administrative departments, and fixed costs. As was stated earlier in the discussion, variable costs are absorbed as incurred, and fixed costs charged on an hourly basis. Each month a statement of variable overhead costs plus direct labor is prepared for each production center and the rate per hour computed. This statement is for a six-months' period. Each foreman secures a copy of the statement for his center, and the works manager receives a copy of the complete report. A similar report, but excluding direct labor, adding fixed overhead and showing certain variable expenses in total rather than in detail is prepared at the end of each six months for executive review.

The statements of overhead costs are the last to appear in point of time, being preceded first by a detailed profit and loss analysis and second by a detailed statement of costs by alloys for each of the processes: remelt furnaces, reclamation furnaces, scalping, rolling, and finishing.

Profit Analysis

On Exhibit 6 the costs and margins for two different gauges of a particular alloy sheet are analyzed to illustrate the economic problem of selecting the proper price and production program. The basic problem under consideration is the best utilization of finish

ANALYSIS OF PROFITABILITY OF 2 GAUGE SIZES
IN RELATION TO FINISH MILL CAPACITY

	Light gauge	*Heavy gauge*	*Ratio light to heavy*
Machine hours per pound of finished weight			
Average all lots	.002044	.001016	201
High	.004640	.001840	252
Low	.001250	.00740	169
Lots in sample	39	15	
Per cent of weight scrapped to finished weight	80.3%	56.7%	142
Pounds of finished weight per machine hours of finish mill time:			
1 ÷ .002044	491		
1 ÷ .001016		988	
* *		*	
Gross sales price per pound	$.4159	$.3175	
Mill net per pound	.1000	.0500	
Sales value per machine hour of production	204.21	313.69	
Rental at 5% of sales	10.21	15.68	
Mill net per machine hour[1]	49.10	49.40	
Less Rental	10.21	15.22	
Mill net after rental[2]	38.89	34.18	
Margin on pig—if 1¢ per pound	4.91	9.88	
Company margin per hour[3]	43.80	44.06	

Conclusions:

[1] If company owned rather than rented, the heavy gauge is the most profitable use of finish mill.
[2] If company rents and can sell all its pig, light gauge is best.
[3] If company rents but has excess pig capacity, heavy gauge is best.

EXHIBIT 6

mill capacity. The limiting factor at the Trentwood mill is finish mill capacity, for the mill was so constructed as to permit the production of more metal in coil form than can be put through the finish mill if a variety of finished products is required. One aspect

of unbalanced capacity is that light gauges require more finish mill time per pound than do heavy gauges. Given a choice between two gauges at given prices, which should be pushed if you are in a sellers' market, and which in a buyers' market?

Analysis of machine time for representative samples of the two gauges, i.e., lots identical in all specifications except gauge, disclosed that it required twice as much machine time per pound of finished weight for the light gauge, and that it had a higher scrap loss—80.3 per cent compared to 56.7 per cent. Converting the machine time per pound to pounds per hour gave 491 and 988 pounds respectively for light and heavy gauge. Since the plant is leased on a minimum or a per cent of sales, whichever is larger, the mill yield depends upon whether or not rent is paid. Another way of looking at it is that if rent is not paid on a sales basis, the situation is comparable to a company that owns its plant. The pounds per hour were converted to dollars per hour by multiplying by the gross sales price, and 5 per cent of this gave the rental per hour of production. The profit margins are assumed for illustration, but approximate the relative difference between the gauges. The margins per pound, if rental were not deducted, were almost equal. If rental is paid, the light gauge is more profitable. In a sellers' market where output is rationed, therefore, the light gauge would yield more profit for the limited finish mill facilities available, and in addition would leave more pig for sales to customers. In a buyers' market, however, it would be unwise to judge the profitability of the two gauges on the basis of market prices alone, and the margin of pig should be added. The addition of one cent per pound would throw the balance to the heavy gauge and give better utilization of the combined plant facilities. Keeping costs on a market basis at each enables management to judge the performance of each plant, but economic analysis enables management to determine when the percentage margin at one plant should be reduced to increase the dollar profit for the integrated operation.

COST LINES

An incentive plan, like any other tool, requires constant attention. (*A. B. Ladeau, Utica*)

* * * *

There must be awareness of the volume that can be expected from every production machine and facility, their condition of repair and degree of efficiency in relation to the newest developments that may be available to competitors. (*W. V. Agliana, Greenwich*)

* * * *

The most difficult costs to control are those which are so inconspicuous that it is almost impossible to isolate them for scrutiny. (*Sigurd Tranmal, Rochester*)

* * * *

I used to say we should be making and accounting for bricks, not electric motors; then I talked to a brickmaker and learned that there are over sixty varieties of common brick with variations in weight, material, size, facing, and finish. (*E. B. George, Dayton*)

* * * *

Overhead expense has risen sharply . . . The accountant must widen his knowledge of all departments. (*K. R. Rickey, Chicago*)

* * * *

Many unimportant details have crept into periodic reports to top management which make the figures unreadable. (*R. H. Meystre, Syracuse*)

* * * *

Our experience has taught us that we can have close control over work in process without interrupting production . . . We take inventory at night with the swing and graveyard shifts; we have also used Saturday. (*D. Y. Rogers, San Francisco*)

* * * *

There are many times when results reflected in cost statements do not coincide with what management believes. The accountant needs a system that will give him reliable information with which to convince management that his figures are accurate and representative. (*Elvin E. Hart, Des Moines*)

A SIMPLIFIED INVENTORY PROCEDURE

by RICHARD C. FOX, Chief Cost Accountant,
General Armature & Manufacturing Co.,
Lock Haven, Pa.

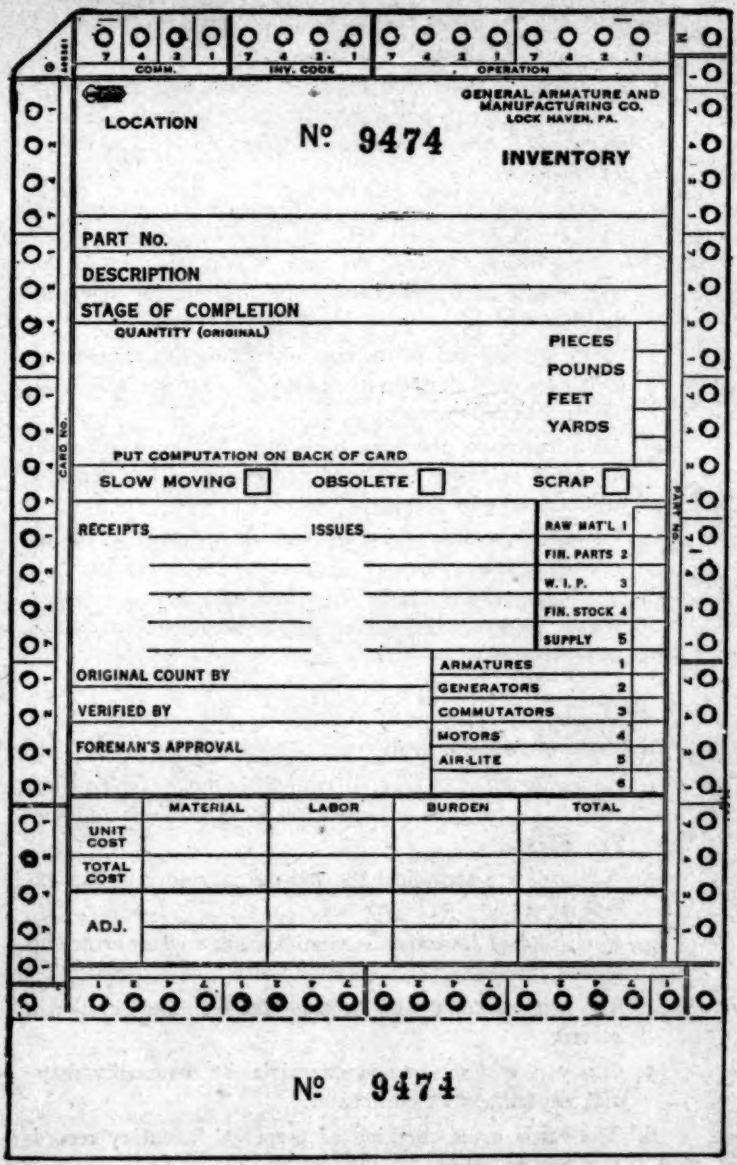
THE PROBLEM of physical inventories is one that confronts small and medium sized organizations at least once a year. If we are to follow the premise that this function is one of the necessary evils of doing business, then it is in order to consider how it may best be accomplished. The problem is to acquire accurate counts with the least disruption, to evaluate this material and arrive at a proper summarization in the shortest possible time after the physical count in order that management may have the benefit of sound inventory and cost of sales figures for the period involved.

It is becoming an increasingly common practice in meeting this problem to use a card form of one type or another. After trying several types we have found one that meets all the requirements for our purposes. This is a keysort card (Exhibit 1) and covers such necessary data as the item description, identifying number, quantity, unit of count, stage of completion, and location for counting purposes, as well as initials of the counter and verifier. The card also provides space for pricing, extensions, and mark-down for the cost department following the physical count.

Keysort Procedure

Our method of inventorying through use of these cards may be stated briefly as follows:

1. About two weeks before the inventory date, arrangements are made with the head of the production department for the appointment of inventory teams who work in pairs and are assigned specific areas. They are advised that during the course of the inventory they are under the control of and take their instructions from the controller or his appointee in charge of inventory.
2. The chief cost accountant, representing the controller's office, conducts a meeting of these team members to review procedures and instruct them in proper practices or changes from the last inventory handling.
3. Inventory cards are numbered serially and issued in lots



Nº 9474

EXHIBIT 1.

to those responsible for the count not later than the third day preceding the end of the month.

4. The count is made and completed on the first and second days of the month following. The cards have all necessary information entered on them and are left with the inventoried items.
5. An appointed representative of the accounting department goes into a department after all items have been counted and verified and collects the cards, leaving the stub on the spot in case of a later check on the information shown on the card.
6. Cards are received by the cost accounting department and sorted by card number to determine what cards, if any, have not been returned.
7. All information necessary for sorting is then punched on the cards, and they are sorted into groups of like items by product and part number.
8. The cards are then priced and extended with the extension verified by a checker.
9. The cards are sorted into groups for whatever summarization is required and adding machine tapes are taken on each group to be posted to a summary sheet.

Advantages of System

Advantages obtained through the use of this system are:

1. An entire plant is covered systematically in a very short time. Lost production time is not more than one and one-half days.
2. All cards are accounted for and the inventory to that extent is presumed to be verified.
3. Rewriting of inventory is eliminated as well as errors involved therein.
4. The original count card becomes the final and permanent record.
5. It is very easy to sort and summarize by commodity, material, department, or cost center.
6. The cards make checking of perpetual inventory records a minor operation.

7. Final inventory amounts are available in two-thirds the time formerly required by any previous method employed.
8. The use of a punched card, in this case up to seven thousand cards twice a year, has resulted in a simplification in the entire physical inventory procedure. The ease in sorting eliminated many of the more tiresome operations and shortened the time in pricing and summarizing.

CHAPTER AND VERSE

Accountants need bifocals rather than just reading glasses, in order to see over the tops of their reports. (*G. E. Nunn, New Orleans*)

* * * *

If depreciation is to figure in accounting statements on the basis of current purchasing power, such a method should apply to all items on the balance sheet. This procedure is obviously not practical. (*E. F. Dow, Hartford*)

* * * *

Like most other special devices, the lifo basis of inventory valuation works out to an extreme disadvantage under certain unusual conditions. (*W. J. Barnwell, Hampton Roads*)

* * * *

There is a definite trend toward complete functional accounting for motor carriers under the Interstate Commerce Commission Uniform System of Accounts (*F. S. Dole, Boston*)

* * * *

The cost accountant of today must work closely with the estimators. (*P. D. Kaser, Toledo*)